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SNAILS ON A PERSIAN HILLSIDE

Ecology—Prehistory—Gastronomy

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The archeologist who is prehistorian may expect snail shells in his excavations. Sometimes, even though the site may be far from the nearest seas, such shells are marine and often were used as decorations, indicating the continuity of human vanity through the ages. Generally, the archeologist has had little interest in such shells as snails, or even in the generic and specific identifications furnished him by a malacologist; instead, the archeologist is interested in any cultural uses of the shells, and is intrigued by problems of their geographic origin and the possibility of tracing prehistoric trade routes.

However, to the ecologically-oriented archeologists and the various natural scientists with them working the past fifteen years in Iraq and Iran, some of the local terrestrial snails have become of prime interest, particularly as potential indicators of past environmental conditions (including climate), and as a source of food for past populations. Thus the continued presence in archeological sites of the same species of snails in the same localities in northern Iraq, for periods sometimes measured in the tens of thousands of years, has been used, with other evidence, to make a tentative reconstruction of the

environments of that area over those periods (Reed and Braidwood, 1960).

This environmental reconstruction, based primarily on zoological data, is partly in conflict for some time-periods with the glaciological evidence of Wright (1961) and the palynological evidence of Solecki and Leroi-Gourhan (1961). Wright's studies indicate a colder climate for the period of the Würm maximum of the late Pleistocene than postulated by Reed and Braidwood for those parts of this period for which they had zoological remains, mostly of mammals and snails. Conclusions derived from study of the pollen-grains recovered from Shanidar Cave in northern Iraq do not contradict Wright's glaciological evidence, but do indicate more fluctuating climatic phases during the periods of the Baradostian and Mousterian cultures than postulated by Reed and Braidwood.

Obviously if zoological remains, such as snail shells, are to be useful in assessing past environments, the ecological conditions of life—and particularly the environmental limitations within which each species can live—must be known. At present, such ecological data are not known precisely for any animal population of southwestern Asia; while in general the botanical assessment of past environments is probably capable of more exactitude than is one based on zoological evidence, the latter should not be ignored, and this present paper is a preliminary effort toward an understanding of the ecology of some of the snails excavated in various of the archeological sites in Iraq and Iran.

To be useful as a climatic indicator, an animal population should have narrow and definite environmental limitations, and these should be known. For instance, a snail which ranges from the Dead Sea to the Iranian Plateau, as does *Helicella langloisiana* Bourguignat, is obviously useless as a climatic indicator (Biggs, 1962).[1]

However, as our knowledge of the ecologic tolerances and limitations of each animal and plant species increases, we can

[1] The same criticism might be brought against the use of *Helix salomonica* as an environmental indicator, since it had been reported (Biggs, 1960) from Jericho in the lower Jordan valley. However, it is now believed that this identification was an error (Biggs, personal communication).

use the data derived from combinations of species, each with varied requirements and with different present geographical ranges, to clarify our concepts of the changing environments of the past.

In all such attempts at environmental reconstruction we begin with the assumption that a biologic population of a past period, as represented by identified remains, had the same ecological requirements as do members of a species with the same morphology as studied today. In general, these assumptions of

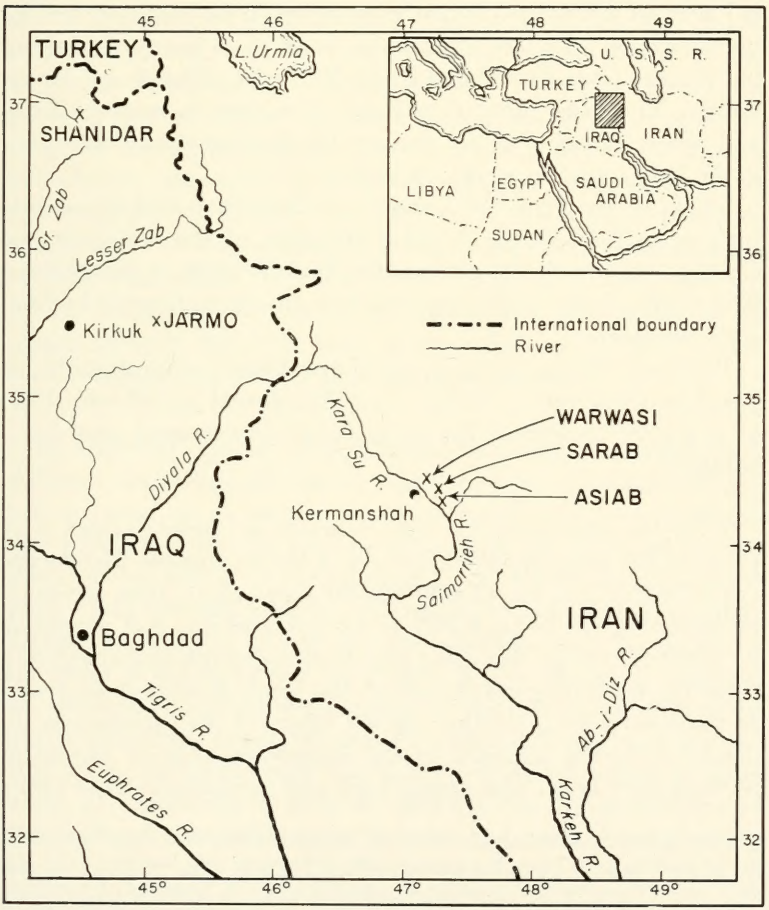

Fig. 1. Map of the area discussed, showing the archeological sites mentioned.

evolutionary stability and ecological uniformitarionism upon which we build our paleo-ecological reconstructions are probably more valid than is the loose framework of our present knowledge, but we are warned by Johnson (1960), even if in a different context, that these assumptions may be less valid for the more precise details we hope to learn in the future.

In addition to the climatic problems outlined above, the steady increase in numbers of one kind of snail, *Helix* (*Naegelea*) *salomonica* Naegele through the late Pleistocene and into the early Recent (post-Pleistocene) in all archeological sites of northern Iraq, is considered to be evidence for the increased use of these animals as food by a steadily-growing population (Braidwood and Reed, 1957; Braidwood and Howe, 1960). The same general pattern is evident in western Iran, and other species of *Helix* during this general period were similarly being used in northern Africa.

Thus by the time the fourth[2] southwestern Asiatic prehistoric expedition of the Oriental Institute of the University of Chicago was ready to go into the field in 1959, a preliminary field study of the snails important to the archeologists had become necessary.

Previous observations in northern Iraq and the problems posed by them were as follows (see Braidwood and Howe, 1960, as a general reference for geography, environment and chronology):

1. *Helix salomonica* is not common in archeological sites prior to the late cave-living period of the uppermost Pleistocene (i.e., the Zarzian, ca. 15,000-12,000 years ago), then increases in concentration to ca. 8,500 years ago, and was still numerous at 7,000 years ago, but after that it disappeared almost entirely from the archeological record of the area. It cannot be found at present in some of the regions where it was previously so plentiful, as for instance in the immediate area of Jarmo in northeastern Iraq. The appearance and increase of these snails

[2] The previous expeditions had been in 1947-1948, 1950-1951, and 1954-1955, all in northeastern Iraq. The fourth, 1959-1960, went into western Iran. All four expeditions have been under the direction of Dr. Robert J. Braidwood of the Oriental Institute, University of Chicago. The present author was a member of the two last expeditions.

in archeological sites are undoubtedly to be correlated solely with changing human food-habits, but is their disappearance from the archeological record due solely to changing human food preferences? Possibly local destruction of the environment (deforestation and brush-cutting, cultivation, over-grazing and soil erosion) have destroyed the micro-habitat necessary for the species so that its present distribution is discontinuous. The species may thus be listed as "abundant" over much of northern Iraq at present (Harris, 1961), and have a number of localities listed (Biggs, 1959) while yet being locally eradicated in an area (as at Jarmo) where once numerous. Harris writes in general for the terrestrial gastropods which he has listed as abundant, "As long as some perennial plants are present, the supplement of annuals is quite sufficient to provide food for the limited faunas common today. Where perennials are absent, and only a poor annual flora is present, snails do not occur, even though the rainfall is adequate." However, the situation is not so simple, as there may well be a sequence of local eradication with the deterioration of the environment; for instance, as mentioned, *H. salomonica* now seems to be absent entirely from the area around Jarmo, whereas *Levantina kurdistana* (L.Pfr.) still flourishes there.

2. Different species of *Levantina* have been recorded from different archeological sites in northern Iraq. *L. mahanica* Kobelt is found, in at least one long-occupied site, that of Shanidar Cave, for several tens of thousands of years, where the shells of this species occurred earlier (ca. 60,000 or more years ago) than did those of *H. salomonica* (somewhat more than 50,000 years ago) and in greater numbers than the latter in the older deposits (prior to 27,000 B.C.). However, shells of *H. salomonica* are more numerous in the later, post-Würm deposits (Solecki's layers B and A) which coincide with the period when this latter snail was being gathered for food in other areas of southwestern Asia. In general, the concentrations of the shells of *Levantina* never become high in archeological remains in Iraq and Iran, and one assumes that it was rarely, if ever, used for food. One wonders, too, why it was not so used, since it is a large and meaty snail. However, the number of

L. spiriplana (Olivier) found together at Jericho, in the lower Jordan valley, suggested to Biggs (1960) that this species of *Levantina* was being eaten at one time at that site.

Levantina has managed to survive, as at Jarmo, where *Helix salomonica* cannot now be found. Moreover, at the three sites (Shanidar Cave, Jarmo, and Warwasi), where recent collections have been made, the species of *Levantina* reported from the prehistoric levels are the same (*L. mahanica*, *L. kurdistana*, and *L. diulfensis* [Mousson], respectively) as are those found in each of the areas now.

3. At the strictly taxonomic level, are the different species of *Levantina* reported from northeastern Iraq (*mahanica*, *kurdistana*, *guttata* [Olivier]) valid species, or are they—and the forms since collected from western Iran (*guttata* and/or *diulfensis*)—merely geographical variants (i.e., subspecies) in a wide-ranging and continuous population (one species), the different parts of which exhibit considerable morphological differentiation?

It was with such questions in mind that the members of the Iranian Prehistoric Project went into the field in west-central Iran in 1959. We cannot claim to have solved any of these problems, but we have added to our observations, and we feel that a presentation is due of these, as well as of our present level of understanding.

Unfortunately, late 1959 and early 1960 was a poor time for "normal" environmental observations. The season was an exceptionally dry one over all of southwestern Asia. In the area of Kermanshah, west-central Iran, where our group was located, unusual cold and snow in November was followed by a long period of winter dryness, during the greater part of what is usually the rainy season. Then there was more snow in March and finally some rain in April.

Observations to be reported were thus made in the area of Kermanshah under the above-described circumstances. The Kermanshah valley is a flat-bottomed alluvial valley, at a general level of 4,000-4,400 ft. (ca. 1,230-1,330 m), surrounded by mountains, some of them high, steep and rugged. The aver-

age annual precipitation is variously reported as 13.1 in. (Robison and Dodd, 1955) to nearly 17 in. (Bakker, 1956; Ganji, 1960: the latter's figures are for 15 consecutive years.) This precipitation occurs entirely during the typical Mediterranean "rainy season" (October to May, with March the month of heaviest rain). The "average" is, however, not the "normal," as wide annual fluctuations occur, from 9 in. to 24 in. (22.5-60.0 cm), although such extremes may not occur oftener than once in 35 years (Bakker, 1956). Even two seasons recorded as having the same precipitation could differ widely in the ecological results of that snow and rain, depending upon the temperature at the time, the intensity of the rain (or depth of snow), and particularly upon the seasonal distribution.

The valley floor and much of the adjacent valley walls are not now forested, and the botanists who have studied there seem agreed that probably the areas now unforested have mostly not been forested as long as present climatic conditions have prevailed. Actually, the area seems to be one of an environmental transition, as measured by floral zones (Bobek, 1951; Pabot, 1961). The valley floor is now intensively cultivated, and the valley walls heavily grazed and subjected to continuous bush-cutting (I do not say brush-cutting because the vegetation is too sparse to be called brush.) To what extent the human activities, continuous for several thousand years, have changed the original environment we cannot assess nor can we at present definitely reconstruct the pre-agricultural environment.

All of the above environmental factors, not available to museum malacologists intent on taxonomic identifications, are pertinent to the understanding of our problems. Actually, we need to know additional types of ecological information not yet gathered, such as the distribution, both geographically and environmentally, of each species represented. Precise data of this type would inform us concerning the limits within which the total environment might vary and yet allow combinations of certain species of snails to persist at one spot, as at Warwasi. However, not only is such information not yet available, but the nomenclatural confusions concerning certain of these species are such that one finds difficulty in interpreting some of

the identifications as published. It would be most desirable to have the collecting, identifications, and ecological studies accomplished by one person or a coordinated team. Additionally, we should know the fewest number of feeding periods per year which will support each population of snail, and also the kinds of variables (maximum and minimum daily temperatures and maximum and minimum daily precipitations) which control the emergence, feeding and breeding of each species. Eiseley (1937) has considered in some detail other factors of the ecology of terrestrial gastropods which have bearing on paleoenvironmental interpretations, and several other authors have also considered different aspects of this general problem.

Some observations and collecting of empty shells had been accomplished prior to the April rains, and by that time data from several excavations could be added (Braidwood, Howe, and Reed, 1961). Our observations were concentrated on *Helix* and *Levantina*, for these alone (so far as we can see at present for the area of our studies) are part of our more general prehistoric archeological problems. These preliminary observations were as follows:

1. Shells of neither *Helix* nor *Levantina* were found anywhere on the open valley floor, on open rounded well-grazed hills, in areas adjacent to streams, or in the typical oak-hawthorn-pistachio forest (Bobek, 1951) of some of the nearby hilly areas.

2. Adjacent to the archeologic site of Warwasi (fig. 2) in the Tang-i-knisht valley, there is a southwesterly-facing, rock-strewn slope covered with thornbushes and with a cliff above. On the slope the most common shell was that of *Helicella langloisiana*, occurring by the thousands. Some of these were sharply-keeled, some almost rounded on the edges of the whorls, with all gradations between these extremes. The second shell, in frequency, was the high-spired *Jaminia* (*Euchondrus*) *albula* (Mousson). Next most common was *Levantina diulfensis;* the *Levantina* shells were accumulated at the base of the cliff and some scattered down the slope. Fourth in frequency were shells

of *Helix salomonica*, found only on the slope. Rarest were shells of *Buliminus* (*Buliminus*) *egregius* Naegele and *Zebrina carducha* (Mertens), which were found only in cracks in the cliff and, presumably fallen from there, at the foot of the cliff.

3. Shells of *Helix salomonica*, but of no other snail, were found in open fields on the top of the low divide between the Kermanshah valley and the next valley to the south. The altitude was around 5,500 feet (ca. 1,700 m) and the shells were associated here only with a hardy ground-hugging perennial too soft to be called a shrub but yet too resistant to be removed by the primitive ploughs used in the area. This circumstance agrees with the observations in Iraq of Harris (1961) on the role of perennials in the survival of snails, but one wonders what factor in this particular locality led to the survival of *H. salomonica* and no other species.

4. Shells of *Helix salomonica* were found in great numbers in an archeological site (Tepe Sarab) located in the open Ker-

Fig. 2. The hillside and cliff at Warwasi, where living snails were collected in April of 1960. The Paleolithic archeological site of Warwasi is the dark overhang at the base of the cliff, almost directly above the car.

manshah valley (Braidwood, Howe, and Reed, 1961); Tepe Sarab is now dated at nearly 8,000 years ago and is thus probably somewhat more recent than is Jarmo. Large numbers of *H. salomonica* in a site of this period agree with our findings in northern Iraq. We are not suggesting that *H. salomonica* was the major food source at Tepe Sarab (nor at any other archeological site), as: a) in our experience, these snails can only be gathered during or following a rain, and; b) at Sarab, as at Jarmo, the people already had cultivated grains and domestic animals.

5. In a site (Tepe Asiab), probably some 2,000 years older than Tepe Sarab and less than a mile distant, but near a permanent stream (the Kara Su) in the valley's center, *H. salomonica* is extremely rare; the major molluscan protein source here seemingly was a clam, *Unio tigridis* Bgt. (So far as we know, these earlier people at Tepe Asiab did not have cultivated grains or domestic animals.) In northern Iraq at the same time (ca. 10,000 years ago) we think *H. salomonica* was being eaten in some quantities; perhaps the easy availability of the fresh-water clams, still present in the river adjacent to Tepe Asiab, made the gathering of snails unnecessary.[3]

6. In the rock shelter of Warwasi (Braidwood, Howe, and Reed, 1961), adjacent to the slope and cliff mentioned in paragraph 2 above, snail shells are found sparsely but continuously through most of the Zarzian and through all of the deeper Baradostian and Mousterian levels (these latter at least 40,000 years old and probably older). Shells of *Helix salomonica* become numerous in the uppermost Zarzian layers (about 12,000

[3] It is obvious, thus, that local biotic and/or cultural patterns change the local archeological findings, making widespread archeological exploration necessary before a total picture emerges. In the excavations at Tepe Sarab, for instance, *Unio tigridis* is rare, although the clam-laden Kara Su is no more than a half-mile away. Within some 2000 years a major shift in food-habits had occurred and the people simply didn't gather clams anymore. Similarly today in the same region, we were told that the people will not eat clams or snails, even under conditions of extreme starvation. There is no truth to the assertion sometimes made by some prehistorians that primitive people ate anything and everything they could gather. There is now, and seemingly has always been, the important factor of the "cultural filter" in the collection of human food-stuffs, and consequently in the comparative archeologic record.

years ago), at which time these snails probably were being gathered for food. Throughout these tens of thousands of years of the later Pleistocene the species represented are the same as those still present on the hillside and, except for the *H. salomonica* of the more recent Zarzian levels, are considered to be no more than random strays into the cultural deposits. In levels below the upper Zarzian, *Levantina* is the most numerous, and occurs earlier than any of the others; at its earliest occurrence it was exactly the same *L. diulfensis* as found on the hillside today.

Subsequent collections of living snails, on April 9 and April 18, 1960, were made on the slope and cliffs immediately adjacent to the site of Warwasi in the Tang-i-knisht valley, which is a lateral side-valley opening southerly into the main Kermanshah valley close to the town of Kermanshah. The mouth of the secondary valley is bounded by high limestone cliffs, with steep slopes of soil and talus rock at their bottoms. It was on such a slope (fig. 2), southwesterly facing, that we did our collecting. Toward the base of the slope there was relatively little fallen rock, but higher and closer to the cliff the tumbled rock was thick. Thorn-bushes, rarely over 10 inches high and spaced some 10 or 15 feet apart, dotted the hillside, even growing among the fallen rocks but not up on the cliff. The ground between the thorn-bushes is quite bare since the slope is heavily overgrazed. This particular slope could be duplicated thousands of times around the Kermanshah valley; while we can say the slope is typical of the area today, we must also assume that the degenerate floral assemblage represents only a remnant of the "natural" vegetation (whatever that may have been) before intensive human use had removed most of the less hardy plants. Thus we cannot now imagine the appearance of these steep hillsides some 8,000 years ago.

On the two nights mentioned, there were continued gentle rains, followed by cool cloudy mornings (11°C-14°C ground temperature) with occasional drizzle. Living snails were asurface both mornings. Since the conditions and the collections were generally similar, the descriptions of the two events will be combined.

SPECIES ACCOUNTS

(Identifications were made by Rev. H. E. J. Biggs, from living specimens air-mailed to England; see Biggs, 1962.)

1. *Helix salomonica:* Most of these snails were found above ground, but under the thorn-bushes on the lower three-fourths of the slope. The snails were extended and moving, not up in a bush, but were generally on the accumulation of dead leaves and grass under a bush or at its edge. Only two individ-

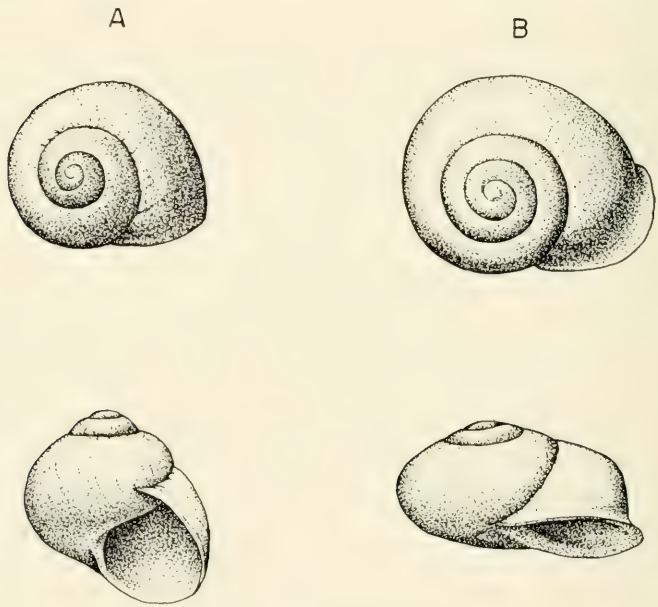

Fig. 3. A. *Helix salomonica.* B. *Levantina diulfensis.* Natural size.

uals were seen out between bushes, on practically bare ground. A few were found under rocks (although none could be found under rocks between rainy periods). The population of *Helix* thinned out up the slope, and none were found in the upper fourth of the slope, although thorn-bushes occur on that upper fourth of the slope. On April 18 (although not on April 9) the snails were observed copulating; of 340 picked up on the slope on the latter date, 12 pairs were coupled, and many more of the living snails did so in the jars after being collected.

2. *Levantina diulfensis:* These snails were first found about halfway up the slope, under identical habitat conditions (so far as could be observed) as the *Helix*. They became much more numerous on the upper parts of the talus slope and on the cliff itself and continued on to the top of the cliff, a near-vertical distance of at least 500 feet. On the upper parts of the talus slope, and on the cliff, they usually occur on bare ground or rock, or on occasional cliff-side patches of moss or grass but unprotected by thorn-bush.

3. *Jaminia* (*Euchondrus*) *albula* (Mousson): Although quite common as dead shells all over the hillside, living examples on these two mornings were rare. They were found coincident with the *Helix*, but also higher on the talus slope (not on the cliff), in similarly protected spots where detritus had accumulated.

4. *Buliminus* (*Buliminus*) *egregius* Naegele: As dead shells, these snails had been found on the surface of the highest part of the talus slope, but more frequently on the cliff-side itself, not only in protected crevices, but also out on small patches of grass or moss where such occur on the rough cliff. They seemingly did not continue to the top of the cliff, as the *Levantina* did. Whereas the living *Helix* and *Levantina* could easily be collected by the hundreds, *Buliminus* was rare, and only very few living *B. egregius* were found. (Three of these are those mentioned by Biggs (1962, p. 69) as being collected by Kent Flannery on April 17; the correct date is April 18.)

5. *Helicella langloisiana:* When collecting empty shells, this is by far the most frequent snail on the hillside, but the living examples were few on the two mornings specified. The *Helicella* were found on the slope under thorn-bushes and up the cliff on and under small vegetational patches.

6. *Zebrina carducha* (Mertens): The few individuals of this species were not distinguished by the collectors in the field from specimens of *Buliminus egregius;* the two have been confused even by experts, and the proper taxonomic position of the

species *carducha* has only recently been established on the basis of the internal anatomy (Forcart, 1962). As with *B. egregius*, individuals of *Zebrina carducha* were limited to the cliff-side niches. So far as can be determined in retrospect, the two species were collected together.

It is obvious that the ecologic notes made to date on these species of snails are not in themselves sufficient for valid paleoenvironmental conclusions. Still, a beginning has been made, and one continues to wonder how much different the climate could have been and yet have this same gastropod assemblage represented—as it is at Warwasi—for periods of tens of thousands of years of the late Pleistocene. During this time, a major period of glaciation occurred in the Zagros Mts. (Wright, 1961), with considerable depression of the mean annual temperature (possibly, but not necessarily as much as 12° C for the higher areas). The coincidental depression in altitude of the permanent snow-line has not been studied for the northeastern (interior) side of the Zagros Mts., as in the area of Kermanshah, where the annual precipitation is much less than on the outer (southwestern) aspect; in this latter area, the snowline some 20,000 years ago was to be found at approximately 2,100 m to 1,500 m (ca. 6,750-4,850 ft.), if Wright's conclusions are correct.

The permanent snowline on the inner side of the mountains would have been higher (even though the inner side is typically colder), due to a lower annual precipitation (a precipitation possibly no greater than that today [Bobek, 1954]). The mean annual temperature, however, would have been lower (possibly 5° C, possibly more) than that of today, so that evaporation would have been less than it is now with a resultant more humid environment.

Whatever the details of the climatological factors, which should be determined in major part by geological investigations, the snails at Warwasi remain the same. At Shanidar Cave, on the "outer" side of the mountains, there is a human occupation hiatus of some 17,500 years (between ca. 30,000 years ago and 12,500 years ago, as derived from C^{14} determinations), which period neatly coincides with that postulated

for the Würm glacial maximum in North America and Europe. The assumption is that man, because of cold, depressed snowline, and coincidentally depressed treeline, could not live in the region of Shanidar Cave during this period (an assumption which is perhaps questionable for the latter part of the period, when conditions must have been warmer and both snowline and treeline higher).

However, no such occupational gap has been detected for Warwasi (although there are no C^{14} determinations as yet on any of the levels of this site). The inference is that man continued to live in the area of Warwasi, and thus of the Kermanshah valley as a whole, at an altitude of 1,300 m (4,200 ft.) and higher, during a long period when he supposedly was excluded from the region of Shanidar Cave at 700 m (2,200 ft.). One can only say from a study of the fauna (including snails) that there was no noticeable faunal change at Warwasi throughout this period of the last 40,000 years or so of the Pleistocene, and at Shanidar Cave there was no noticeable faunal difference between the last of the Baradostian cultural layers (at ca. 30,000 years ago, prior to the occupational hiatus) and those of Solecki's "Mesolithic" layer (following the cultural gap, and beginning ca. 12,500 years ago) (Reed and Braidwood, 1960).

Perhaps long-term experimental studies on the environmental limitations of the snails of the Tang-i-knisht hillsides, coupled with intensive field studies over varied environmental areas where these snails may be found today, would throw some light on these problems. There is, thus, much work for the future.

GASTRONOMIC EXPERIMENTS

Several kinds of *Helix*, are the edible snails of southern Europe, and the evidence of hundreds of thousands of similar shells in archeological sites of 12,000 to 8,000 years ago in northern Africa, as well as in Iraq and Iran, showed that snails of this genus were being eaten then as well. Obviously, these snails were good human food. Why, however, were the somewhat larger *Levantina*, occurring on the same slopes for at least some tens of thousands of years, and as numerous or al-

most as numerous as are the *Helix* on those slopes today—why were these snails *not* eaten? (At least they do not occur in any great numbers in any archeological site hitherto excavated by the Oriental Institute and so we must assume they were not often gathered in our area; an occasional *Levantina* shell at Jarmo or Tepe Sarab may, we think, be due to a mistake by some small child helping its mother in the gathering.)

It was with pleasurable anticipation, therefore, with respect to the *Helix salomonica* but with some apprehension with regard to the *Levantina diulfensis* that we took more than 300 of the former and more than 200 of the latter and prepared them for eating in the best French tradition (Rombauer, 1951, p. 257). All members of the expedition participated in the experiment (April 19, 1960); indeed, we had a festive occasion, with special "snail-picks" being provided, made from some of the microlithic bladelets from Tepe Sarab (fig. 4). (We are not claiming that these microliths were used originally as snail-picks; we only showed that they could be.) This gourmet experiment proved to our complete satisfaction that both the *Helix* and the *Levantina* are uniformly good.

Fig. 4. Prehistoric microlith from Sarab, mounted to be used as a snail-pick for gastronomic experiments.

However, it was assumed that 8,000 years ago the techniques of French cooking were not available to the people of west-central Iran (although we have no way of knowing, of course, what variety of herbs they may have used to flavor their food), so a few hardier spirits tried a second experiment. Both *H. salomonica* and *L. diulfensis* were boiled 15 minutes, and then eaten hot, without salt or any other flavoring. Surprisingly, they are both acceptable food under these Spartan conditions; the *Helix* comes out of the shell quite easily, the *Levantina* perhaps a bit less so, and the latter retains maybe a bit more mucus (tasteless), but it seems hardly possible that such minor factors were those which restrained the prehistoric

populations of the Zagros slopes from eating the *Levantina*. We found these snails quite tasty, and cannot imagine why they were not eaten in former times; the experiments, from the point of view of such "action archeology," were therefore a failure, although gastronomically a success.

The mode of preparation of the snails for eating under prehistoric conditions is a problem we have not solved. Since most of the shells are intact as we find them, the animals must have been killed prior to extraction, inasmuch as the living animals cannot be extracted from their shells without breaking these. Although the animals could be killed by drowning, we presume that the mode of killing was by cooking, but have no proof of this. We cooked them by boiling, for us a simple and effective method; the boiling does not affect the shells in any way that we could see, although Matteson (1959) noted that extended boiling of certain terrestrial snails from Illinois tends to cause the epidermis to flake away from the rest of the shell. However, extended boiling—if the snails *were* boiled—is not necessary for their preparation as food.

If the snails were cooked by boiling, as we first casually assumed, the question arises as to what were the containers in which they were boiled. Pottery is unknown prior to about 8,500 years ago, and for earlier times, we have no archeological evidence of containers in which boiling water could have been held. In answer to some who have suggested that this earliest pottery was too coarse to have been used to hold boiling water, Dr. Frederick Matson, who assisted in the excavations and has studied the ceramics from Jarmo and Sarab, has written, "The pottery from Sarab and Jarmo could easily withstand boiling water. The vessels are made of fired clay, and, aside from their porosity, would not react with the water. However, I doubt if they were used to boil snails or prepare stews because most of the larger flat-based vessels have very thin bases and there might be a problem with respect to the weight of the water unless the pots were nested in the fire with adequate support beneath them. Also, I do not recall seeing smudge and burning marks on the exteriors of the lower parts of the vessels that would suggest such firing. . . . A small amount of water in a pot full of snails would not require a lot of basal support for

weight. If the pot were covered with a flat slab of some sort (skin, sherd, wood, or smaller jar that just fit the mouth) the snails could be steamed without requiring the presence of much water. . . . I would not want to rule out the boiling or steaming of the snails, because it would be physically possible, but I wonder if it wouldn't be easier to roast them in hot ashes" (Matson, personal communication).

However, as mentioned, pottery was unknown for much of the period for which we think eating of snails to have occurred, and actually for neither the pre-pottery or pottery-making cultures do we have any real knowledge of the mode of preparation of the snails.

In a similar situation in Alabama, where large numbers of snail shells were found in pre-pottery cultural associations, Morrison (1942, p. 381) thought that the snails were steamed in pits beneath a fire. Again, we have no archeologic evidence for or against such a hypothesis; we only know that, both for our sites in southwestern Asia and for those in Alabama (as well as those from prehistoric Jericho [Biggs, 1960]), the great majority of the shells show no signs of charring, and thus we assume the animals were not roasted on hot rocks.

SUPERSTITION

Our cook and two house-boys were town bred; they were familiar with snail-shells as shells, but were astounded to discover that each housed a living animal. They were of the opinion that no one of all the people they knew had any idea that these shells were anything other than what they were commonly regarded to be: snake pillows!

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SUMMARY

The finding of shells of certain terrestrial snails (particularly of *Helix salomonica* and several species of *Levantina*) in archeological context throughout the upper Quaternary of the slopes of the Zagros Mts. of southeastern Iraq and western Iran led to the speculations concerning: 1) the use of *Helix* as food by the prehistoric people involved, and: 2) the possible use of the presence of these shells and others as ecologic indicators of past environments.

Pleasurable gastronomic experiments indicated that both *Helix salomonica* and *Levantina diulfensis* were equally acceptable as food to modern archeologists and their colleagues; however, during the late Pleistocene and early Recent when snails were being gathered for food, all evidence indicates that, in the area studied by us, the *Helix* were eaten and the *Levantina* were rejected. We have no explanation for this choice by the prehistoric peoples involved.

The use (and possible mis-use) of terrestrial snails as paleoecologic indicators are discussed, and some preliminary ecologic notes are made on six species which have been found in late Quaternary archeological sites and which presumably may have importance to paleo-environmental studies. However, only a bare beginning has been made in this type of study, particularly for the area of the Zagros Mts., and much more intensive study is necessary before any valid paleo-environmental deductions can be made on the basis of the terrestrial snails.

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